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(54) **Optical scanner apparatus.**

(57) A dual aperture optical scanner is provided which employs a single laser beam to produce horizontal and vertical scan patterns. The optical scanner includes a housing (32) having first (28) and second (30) apertures, a laser beam source (12), a mirrored spinner (16) having a plurality of facets (76,68,80) with different elevation angles for reflecting the laser beam in a plurality of directions, and a plurality of pattern mirrors (18) within the housing (32) for reflecting the laser beam from the spinner (16) through the first (28) and second (30) apertures to an article having a bar code label to be scanned.

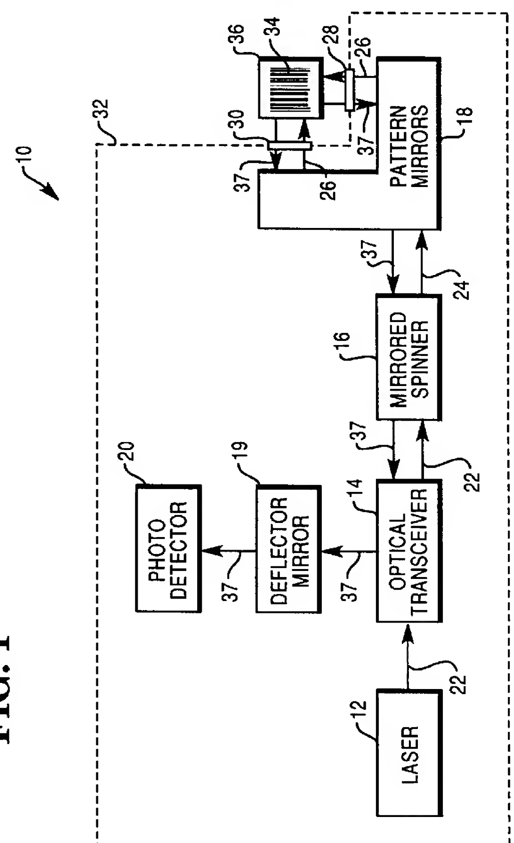

FIG. 1

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The present invention relates to optical scanner apparatus.

Optical scanners are well known for their usefulness in retail checkout and inventory control. Optical scanners generally employ a laser diode, the light from which is focused and collimated to produce a scanning beam. An optical transceiver directs the beam against a mirrored polygon on spinner and then against a plurality of stationary mirrors, and collects the beam after it is reflected by a bar code label. A motor rotates the mirrored polygon, and a detector receives the returning beam. The pattern produced by such a scanner is characterized by lines oriented at various angles to one another.

Typically, optical scanner emit light through one aperture, either horizontal or vertical, but not both. In high performance scanners, light is emitted from several directions through this aperture. In the case of horizontal apertures, a pattern of light is projected onto the front and bottom furnaces of a labelled item. In the case of vertical apertures, a pattern of light is projected onto the front and side surfaces of a labelled item. In low performance scanners, light illuminates only the surface which is facing the aperture.

Also, known scanners disadvantageously require item orientation to ensure that the bar code label is properly aligned in relation to the scanning beams and the aperture. Orientation time slows item throughput and therefore customer throughput. Item orientation may also cause checkout personnel to suffer repetitive strain injury.

It is an object of the present invention to provide high performance optical scanner apparatus which does not exhibit the above disadvantages.

In accordance with the present invention, there is provided optical scanner apparatus comprising a housing and scanner means contained in said housing, characterized in that said housing comprises first and second window portions disposed substantially in first and second planes which are transverse to each other, and said scanner means comprises light source means and deflection means for receiving light from said source means and forming first and second scan patterns for passage through said first and second window portions respectively and into a scanning region external of said housing.

It is a feature of the present invention that the mirrored spinner and pattern mirrors can combine to produce a plurality of scan lines which pass through horizontal and vertical apertures. The scanner can produce a scan pattern which more effectively covers multi-sided articles.

Advantageously, the present invention provides for a dual aperture optical scanner which produces a scan pattern for passage through a substantially vertical first aperture and a substantially horizontal second aperture and which has a single laser and motor.

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings in which:-

Fig. 1 is a block diagram of a scanner embodying the present invention;

Fig. 2 is an exterior perspective view of apparatus including the scanner illustrated in Fig. 1;

Fig. 3 is an interior perspective view of the scanner of Fig. 1;

Fig. 4 is a sectional view of the scanner of the present invention along lines 4-4 of Fig. 3;

Fig. 5 illustrates a reference coordinate system for determining the location and orientation of a group of pattern mirrors within the scanner of Figs. 1 to 4.

Fig. 6 is a plan view of the scan pattern emanating from a first aperture of a scanner embodying the present invention; and

Fig. 7 is a plan view of the scan pattern emanating from a second aperture of a scanner embodying the present invention.

Referring now to Fig. 1 dual aperture optical scanner 10 of the present invention includes laser 12, optical transceiver 14, mirrored spinner 16, group 18 of pattern mirrors, deflector mirror 19, and photodetector 20. Laser 12 includes a laser diode, a focusing lens or lenses, and a collimating aperture. In the preferred embodiment, the laser diode emits visible light within a wavelength range of 670-690 nm and the collimating aperture and focusing lens produce a beam 22 having a beam waist of 220 microns in the center of the read zone.

Beam 22 passes through optical transceiver 14, which includes a mirrored collecting surface and an aperture for passing beam 22.

Beam 22 contacts mirrored spinner 16, which preferably has three planoreflective mirrored facets for producing scanning beams 24. Each facet has a slightly different elevation angle, which preferably differ by increments of about three degrees, resulting in three distinct scanning beam paths. The rotation of mirrored spinner 16 through an angle of about one-hundred-and-twenty degrees moves one facet completely through beam 22. Therefore, scanning beams 24 reflecting from mirrored spinner 16 cover an angle of about two-hundred-and-forty degrees and lie in a shallow cone.

Scanning beams 24 impact a group 18 pattern mirrors, which separate light from the facets of mirrored spinner 16 into a plurality of scan lines 26. In the preferred embodiment, group 18 of pattern mirrors split scanning beams 24 from each facet of mirrored spinner 16 into eight lines 26, resulting in twenty-four lines 26 for

each complete revolution of mirrored spinner 16. Advantageously, all twenty-four lines 26 are produced by only one laser and motor.

It is a feature of scanner 10 of the present invention that some scan lines 26 pass through a substantially horizontal aperture 28 and some pass through a substantially vertical aperture 30 in scanner housing 32 o their way to bar code label 34 on article 36.

Reflected light 37 is redirected by group 18 of pattern mirrors towards spinner 16, which further directs it towards optical transceiver 14. Optical transceiver 14 directs and focuses reflected light 37 at deflector mirror 19, which further directs reflected light 37 towards photodetector 20. Photodetector 20 generates electrical signals representing the intensity of light 37.

Turning now to Fig. 2, apertures 28 and 30 are shown in more detail. Vertical aperture 30 is located within substantially vertical surface 40 and is large enough to illuminate a normal size item.

Horizontal aperture 28 is located within top surface 38 of housing 32 and is large enough to illuminate a normal size item. In this embodiment, vertical aperture 30 is larger than horizontal aperture 28.

Preferably, scanner 10 may be easily adapted to fit in a typical checkout counter 42. It is envisaged that top surface 38 be made substantially flush with the top surface 44 of the counter 42.

Referring now to Figs. 3 and 4, the arrangement of group 18 of pattern mirrors is shown in more detail. The pattern mirrors of group 18 are all flat mirrors. Scanning beams 24 from spinner 16 impact a first set of pattern mirrors 50-62 in group 18 in sequence and reflect therefrom to a second set of pattern mirrors 64-74 of group 18.

The reference coordinate system for pattern mirrors 50-74 is shown in Fig. 5 and includes X, Y, and Z axes. Coordinates Xm, Ym, are measured in inches (centimetres), and angles Xr and Yr, are measured in degrees, with positive angles being measured in a counter-clockwise direction. To get to its final orientation, each mirror is first orientated parallel to the X-Y plane through a point (Xm, Ym, Zm). Each mirror is then rotated through an angle Xr about a line X′ parallel to the X axis and containing the point (Xm, Ym, Zm). Each mirror is then rotated through an angle Yr about a line Y′ parallel to the Y axis and containing the pint (Xm, Ym, Zm). Origin 0 is at the center of spinner 16. These five values uniquely define the planes for mirrors 50-74. Preferred values are shown for each mirror in the following table:

Mirror	Xm	Ym	Zm	Xr	Yr
50	-1.200(3.05cm)	0.500(1.27cm)	-5.302(13.47cm)	33.0	-5.0
52	-1.353(3.44cm)	0.500(1.27cm)	-4.774(12.13cm)	15.0	41.0
54	-3.575(9.08cm)	0.650(1.65cm)	-2.393(6.08cm)	-35.0	10.0
56	-3.575(9.08cm)	0.650(1.65cm)	0.000(0.00cm)	-42.5	90.0
58	-3.575(9.08cm)	0.650(1.65cm)	2.393(6.08cm)	-35.0	170.0
60	-1.353(3.44cm)	0.500(1.27cm)	4.774(12.13cm)	15.0	139.0
62	-1.200(3.05cm)	0.500(1.27cm)	5.302(13.47cm)	33.0	-175.0
64	1.800(4.57cm)	0.525(1.33cm)	0.412(1.05cm)	-33.0	-90.0
66	1.800(4.57cm)	-0.525(1.33cm)	-2.000(5.08cm)	-86.5	90.0
68	-4.990(12.67cm)	8.840(22.45cm)	0.000(0.00cm)	28.0	69.0
70	-4.990(12.67cm)	8.840(22.45cm)	0.000(0.00cm)	28.0	111.0
72	1.800(4.57cm)	-0.525(1.33cm)	2.000(5.08cm)	-86.5	90.0
74	1.800(4.57cm)	-0.525(1.33cm)	-0.338(0.86cm)	-44.6	-90.0

Beam 22 contacts planoreflective surfaces 76-80 of mirrored spinner 16. Each facet has a slightly different elevation angle, resulting in three distance scanning beam paths. In the preferred embodiment, the elevation angles in degrees are 76.95, 79.00, and 81.05.

At the junction of the facets are interface surfaces 81A, B, and C, produced by rounding the edges between adjacent facets. In addition, the edges are cut back further at the bottom of spinner 16. Rounding serves to reduce the torque requirements for rotating spinner 16. At high motor operating speeds, wind resistance is a dominant component of motor torque. Thus, rounding serves to markedly reduce motor torque requirements,

thereby facilitating the use of smaller and less expensive motors. Additionally, it reduces power consumption and heat dissipation.

In operation, laser beam 22 strikes each facet of mirrored spinner 16 in sequence. During the illumination of each facet, scanning beams 24 impact pattern mirrors 50-62 in sequence. First, light reflects from mirror 50 and then from mirror 66 to form scan line 82.

Second, light reflects from mirror 52 and then from 68 as scan line 86.

Fourth, light reflects from mirror 56 and then from mirror 68 as scan line 88.

Fifth, light reflects from mirror 56 and then from mirror 70 as scan line 90.

Sixth, light reflects from mirror 58 and then from mirror 70 as scan line 92.

Seventh, light reflects from mirror 60 and then from mirror 74 as scan line 94.

Eighth, light reflects from mirror 62 and then from mirror 72 as scan line 96.

The eight-step sequence above repeats itself for the two remaining spinner facets, yielding a total of twenty-four different scan lines.

Referring now to Figs. 5 and 6, vertical and horizontal scan patterns 100 and 102 are shown, including the eight,scan lines of Fig. 3. Since each of the three facets of mirrored spinner 16 are inclined at different angles from one another, twenty-four different scan lines 26 are produced.

Claims

1. Optical scanner apparatus (10) comprising a housing (32) and scanner means (14,16,18) contained in said housing, characterized in that said housing (32) comprises first (28) and second (30) window portions disposed substantially in first and second planes which are transverse to each other, and said scanner means comprises light source means (12) and deflection means (14,16,18) for receiving light from said source means (12) and forming first and second scan patterns for passage through said first (28) and second (30) window portions respectivety and into a scanning region external of said housing (32).

2. Apparatus according to claim 1, characterised in that said housing (32) comprises a substantially horizontal surface (38) containing said first window portion (28) and a substantially vertical surface (40) containing said second window portion (30).

3. Apparatus according to claim 1 or 2, characterized by an optical transceiver (24) for transmitting light from said source means (12) and for collecting light reflected from a scanned object and a photodetector (20) for generating signals representing the intensity of the light reflected from said object.

4. Apparatus according to any one of the preceding claims, characterized in that said source means (12) comprises laser means.

5. Apparatus according to any one of the preceding claims characterized in that said scanner meams includes a spinner member (16) for receiving light from said source means (12).

6. Apparatus according to claim 5, characterized in that said spinner member (16) comprises a polygon having three planoreflective facets (76,78,80).

7. Apparatus according to claim 6, characterized in that said facets (76,68,80) are orientated at different angles with respect to a predetermined reference.

8. Apparatus according to claim 6 or 7, characterized in that the junctions between said facets (76,78,80) are rounded.

9. Apparatus according to any one of claims 5 to 8, characterized in that said deflection means include a first set of mirrors (50-62) for reflecting said light from said spinner member (16) and a second set of mirrors (64-74) for reflecting the light from said first set of mirrors (50-62).

10. Apparatus according to any one of the preceding claims, characterized in that said deflection means (14,16) comprise a plurality of flat mirrors (18).

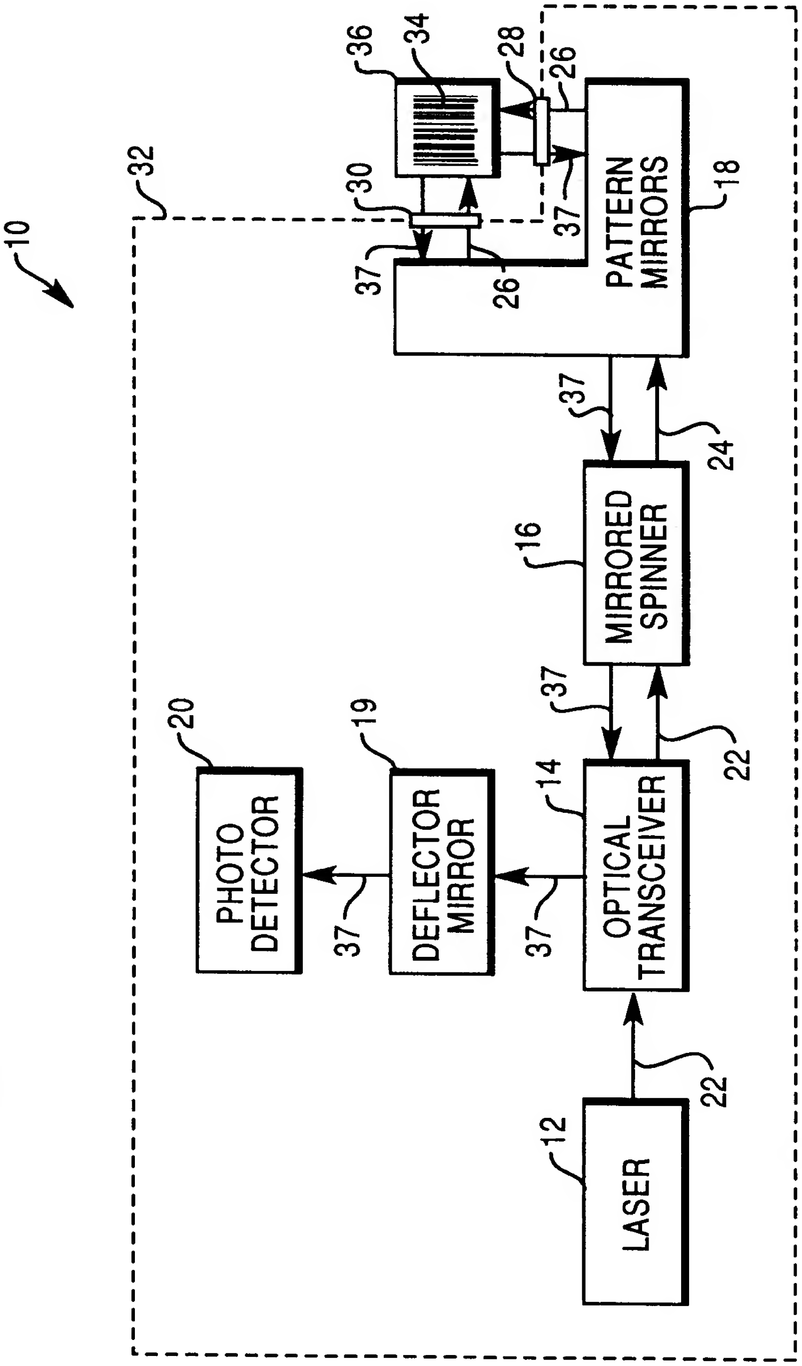
LASER
OPTICAL TRANSCEIVER
MIRRORED SPINNER
PATTERN MIRRORS
DEFLECTOR MIRROR
PHOTO DETECTOR
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FIG. 1

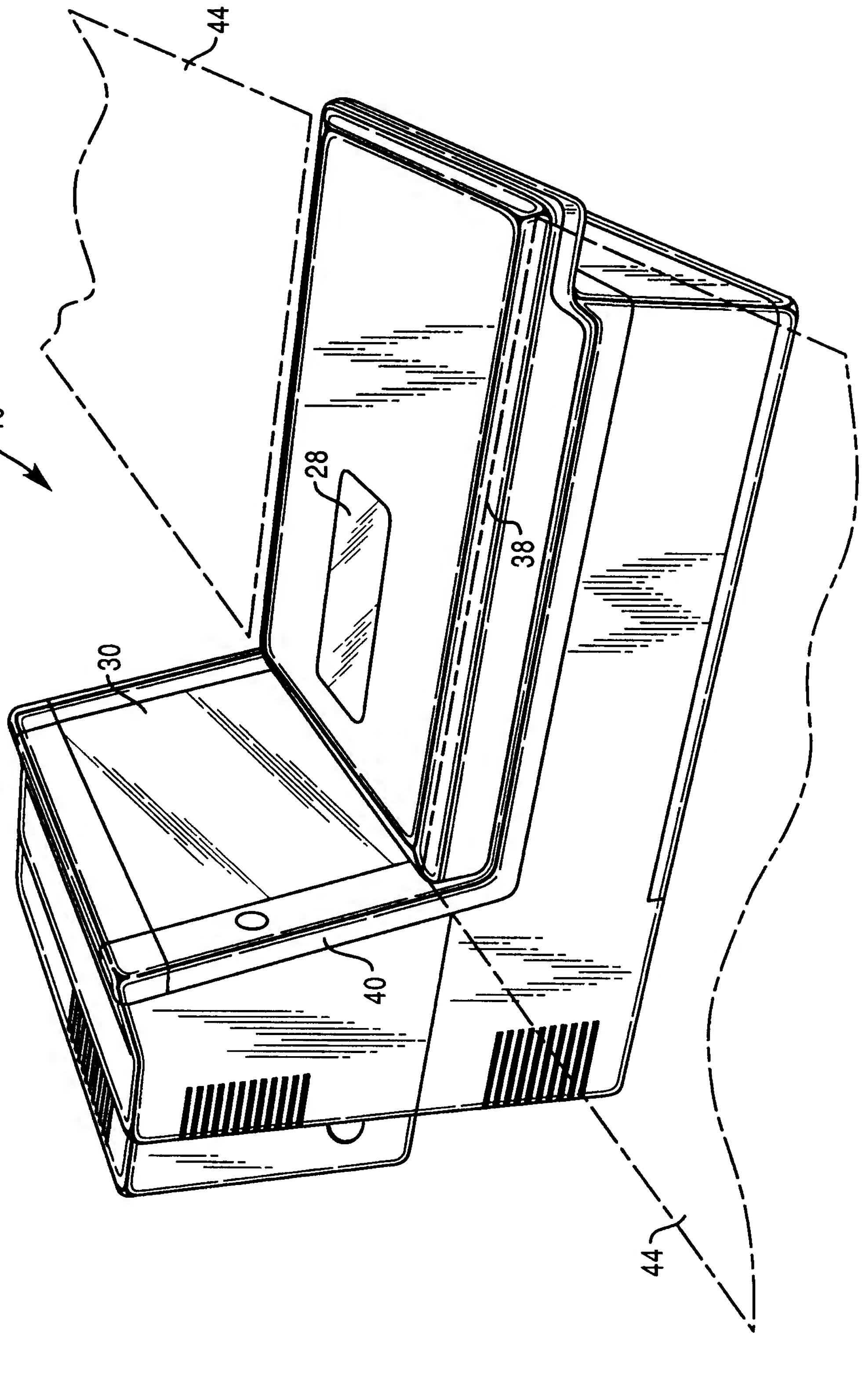
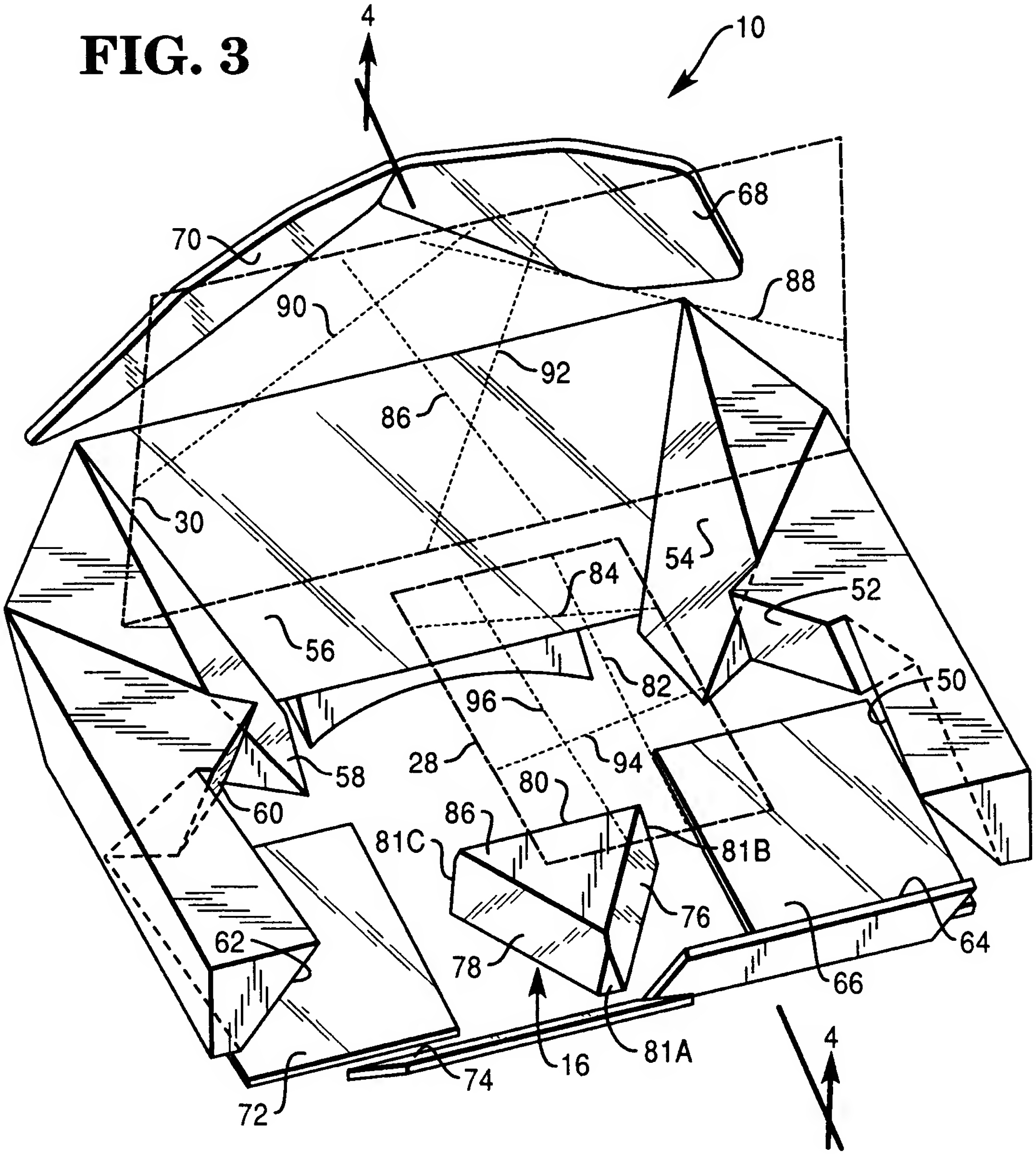


FIG. 2

FIG. 3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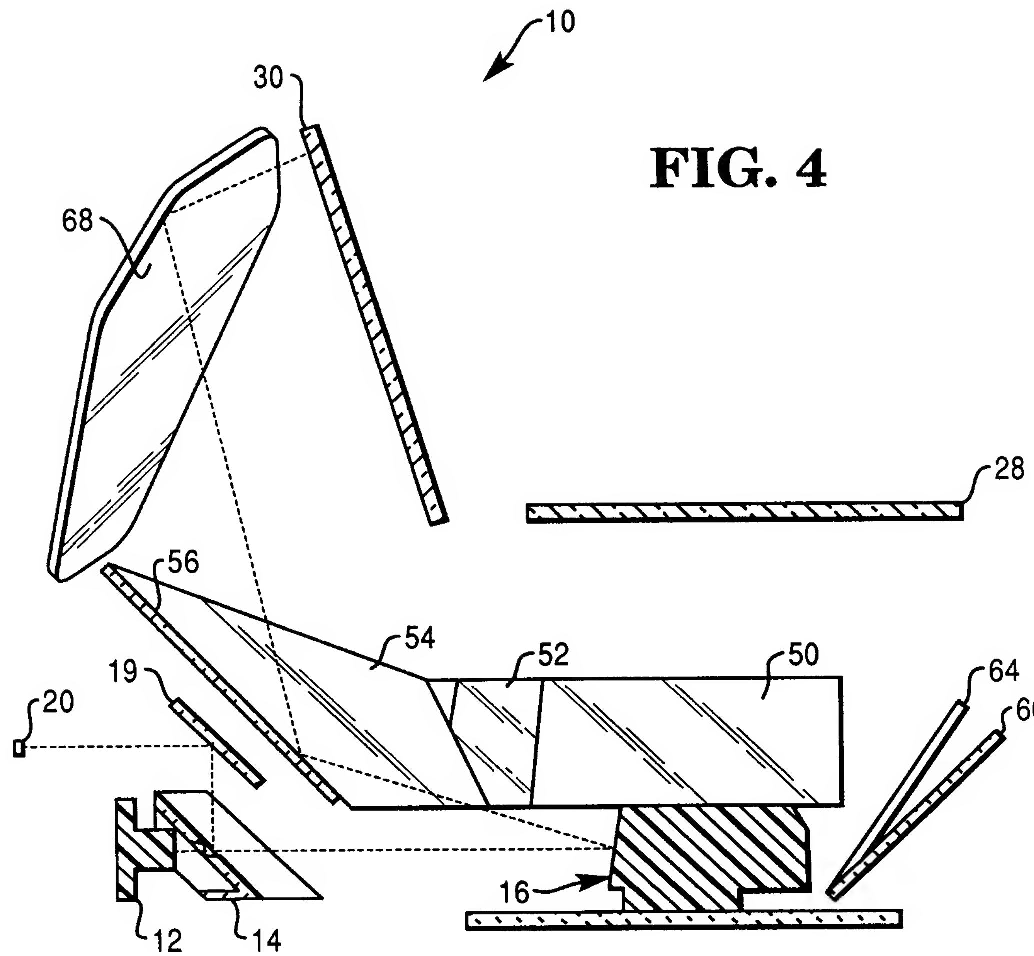


FIG. 4

FIG. 5

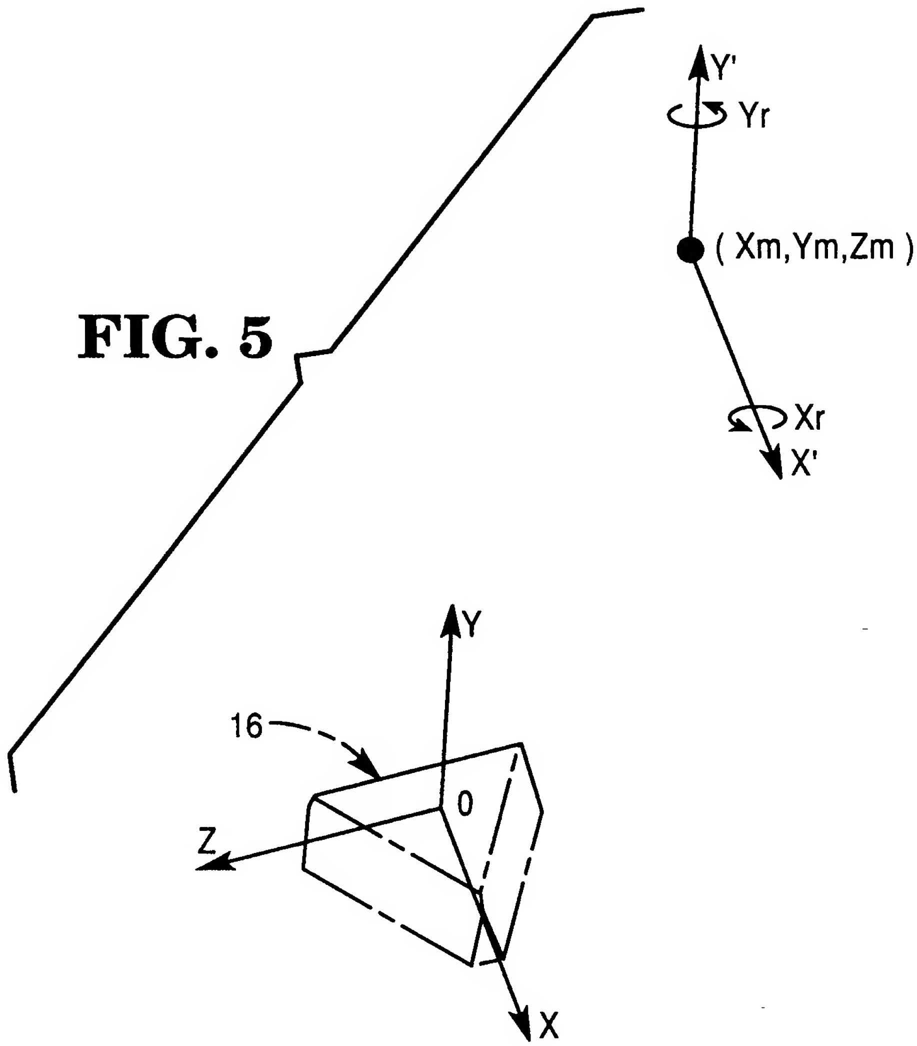


FIG. 7

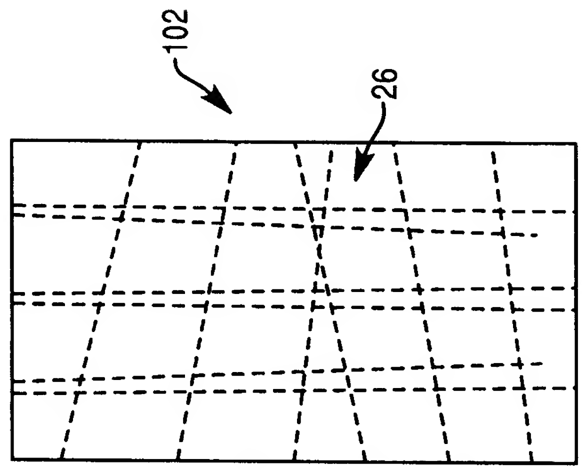
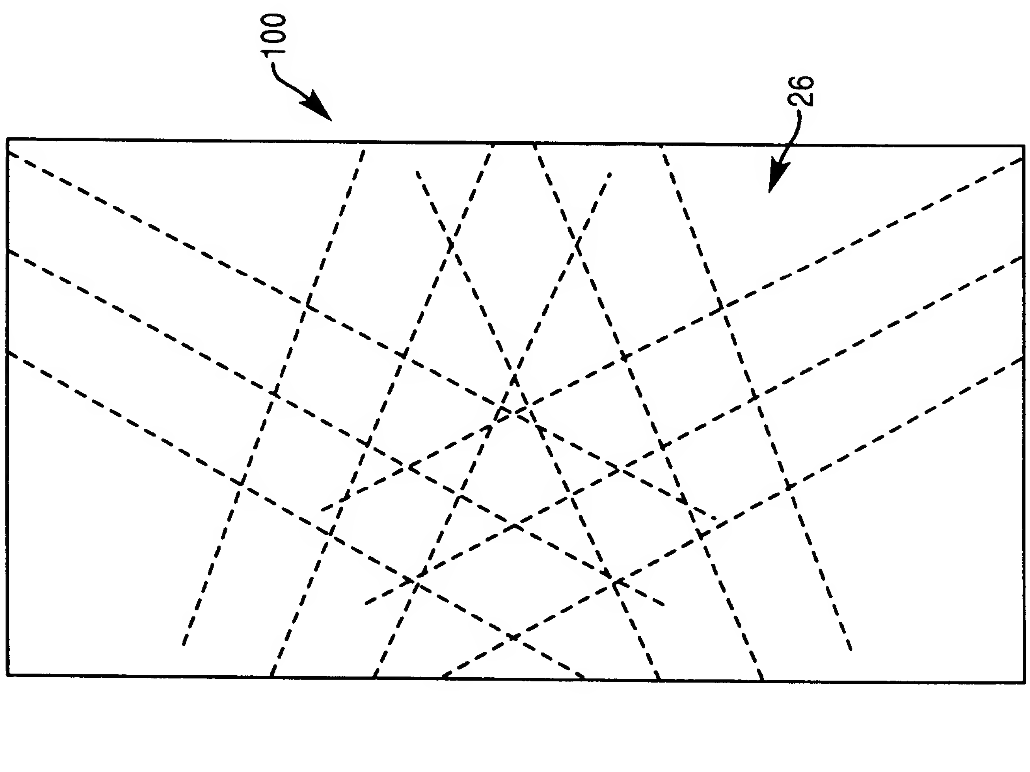


FIG. 6



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EUROPEAN SEARCH REPORT

Application Number

EP 92308848.8

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP - A - 0 444 958 (KATOH HIROKAI) * Totality *	1-10	G 06 K 7/10 G 02 B 26/10
Y	WO - A - 89/05 013 (NCR)	1-4	
A	* Claims 1-10; fig. 1-4 *	5-10	
Y	US - A - 4 652 732 (NICKL)	1-4	
A	* Claims 1-12; fig. 1-6 *	5-10	
A	US - A - 4 799 164 (HELLEKSON) * Totality *	1-10	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G 06 K
G 02 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	22-12-1992	MIHATSEK

CATEGORY OF CITED DOCUMENTS

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